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APPLICATION

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TITLE: TWO-DIMENSIONAL OPTICAL CODE SCANNER WITH SCANNING PATTERN HAVING REGION OF GREATER APPARENT BRIGHTNESS FOR ASSISTING ALIGNMENT OF SCANNING PATTERN

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TWO-DIMENSIONAL OPTICAL CODE SCANNER WITH SCANNING PATTERN HAVING REGION OF GREATER APPARENT BRIGHTNESS FOR ASSISTING ALIGNMENT OF SCANNING PATTERN

CROSS REFERENCE TO RELATED APPLICATIONS

This is a continuation-in-part of 09/047,011, filed Mar. 26, 1998, which is a continuation-in-part of 08/912,147, filed Aug. 15, 1997, now issued U.S. Pat. No. 5,859,417, which is a continuation of application Ser. No. 08/405,585, filed Mar. 17, 1995, now abandoned, which is a continuation-in-part of application Ser. No. 08/268,982, filed Jun. 30, 1994, now U.S. Pat. No. 5,742,038, which is a continuation-in-part of application Ser. No. 08/314,519, filed Sep. 28, 1994, now issued U.S. Pat. No. 5,506,392, which is a divisional of application Ser. No. 08/109,021, filed Aug. 19, 1993, now issued U.S. Pat. No. 5,352,922, which is a divisional of application Ser. No. 07/735,573, filed Jul. 25, 1991, now issued U.S. Pat. No. 5,278,397.

BACKGROUND

The invention relates generally to optical scanners, and in particular to scanners used for scanning two-dimensional optical codes such as bar code symbols.

Optical codes are patterns made up of image areas having different light reflective or light emissive properties, which are typically assembled in accordance with a priori rules. The term "bar code symbol" is sometimes used to describe certain kinds of optical codes. The optical properties and patterns of optical codes are selected to distinguish them in appearance from the background environments in which they are used. Devices for identifying or extracting data from optical codes are sometimes referred to as "optical code readers" of which bar code scanners are one type. Optical code readers are used in both fixed or portable installations in many diverse environments such as in stores for check-out services, in manufacturing locations for work flow and inventory control and in transport vehicles for tracking package handling. The optical code can be used as a rapid, generalized means of data entry, for example, by reading a target bar code from a printed listing of many bar codes. In some uses, the optical code reader is connected to a portable data processing device or a data collection and transmission device. Frequently, the optical code reader includes a handheld sensor that is manually directed at a target code.

Generally, it is necessary to align the scanning beam with the optical code in order to read the code. For example, with the common one-dimensional bar code symbol, which has a pattern of variable-width rectangular bars separated by fixed or variable width spaces (with the bars and spaces having different light reflecting characteristics), the scanner is typically aligned so that the scanning beam moves across all or at least a large fraction of the bars and spaces in one pass.

Some optical codes are two-dimensional, such as the well known PDF417 two-dimensional bar code symbol, in which a pattern of light and dark elements are arranged in rows. A description of the PDF417 bar code symbol and techniques for decoding it are disclosed in U.S. Pat. No. 5,635,697 to Shellhammer et al. and assigned to Symbol Technologies, Inc., which patent is incorporated herein by reference. Other two-dimensional optical codes are known (e.g., MaxiCode, described in the publication, "International Symbology Specification--Maxicode", by AIM International, Inc.). Typically, a two dimensional optical code comprises a grid tiled by regular polygons such as squares or hexagons. Typically a black or white feature or polygon is located at each grid location.

Alignment of the scanning beam can be more important in the case of two-dimensional optical codes than with one-dimensional codes. For example, with the PDF417 symbol, the scanning beam typically moves in a raster pattern, in which the beam traces out a series of spaced apart rows that cover a rectangular area (much as the beam of a cathode ray tube moves across the top row, then the second row, and so forth until reaching the bottom row, before starting over again at the top row). It can be desirable for the rows of the raster pattern to be aligned with rows of the two-dimensional bar code.

Sometimes, particularly in the case of handheld bar code readers, it is desirable to give visual clues to the user to facilitate the desired alignment. For example, with a typical one-dimensional bar code reader, the user sees a visible line (typically a red line) corresponding to the path of the scanning beam, and the line is simply aligned with the bar code symbol.

SUMMARY

In general, the invention features providing an alignment indication for an optical scanner reading a two-dimensional optical code by varying the scanning beam to provide a region of apparent greater brightness. Actual brightness of the scanning beam need not vary, so long as to

the user's eye there is a region of greater brightness that can be used for alignment. For example, in the case of a PDF417 bar code symbol, an elongated brighter region may be oriented so that it is parallel with rows of the PDF417 symbol.

In preferred implementations of the invention, one or more of the following features may be incorporated.

The apparent greater brightness may result because of the persistence of the scanning pattern in the user's vision.

The region of apparent greater brightness may be achieved by providing a greater density of scan lines in the region. Because of the persistence in the user's vision, multiple scan lines appear simultaneously, and thus a region with a greater density of scan lines appears as a brighter region.

The region of apparent greater brightness may be achieved by providing a differently shaped scanning spot in the region (e.g., a larger, or more elongated spot). Persistence in a user's vision may also account for the larger spot size appearing as a brighter region.

The region of apparent greater brightness may be a region in which the density of scan lines is greater and the scanning spot of the outgoing light beam is shaped differently.

The two-dimensional scanning assembly may produce a plurality of generally spaced apart, parallel scan lines that produce a raster-scanned pattern of scan lines on the indicia, wherein the raster scanning assembly comprises a multi-surface reflector having at least first and second surfaces, the first surface producing first scan lines on the indicia, and the second surface producing second scan lines on the indicia, wherein the first and second surfaces are differently shaped and positioned relative to one another so that first scan lines overlap some of the second scan lines, to produce a region of overlapping scan lines on the indicia, and wherein the region of overlapping scan lines produces the region of apparent greater brightness.

The two-dimensional scanning assembly may produce a plurality of generally spaced apart, parallel scan lines that produce a raster-scanned pattern of scan lines on the indicia, wherein the raster scanning assembly comprises a multi-surface reflector having at least first and second surfaces, the first surface producing first scan lines on the indicia, and the second surface producing second scan lines on the indicia, wherein the first and second surfaces are differently shaped and positioned relative to one another so that the spot of the first scan lines is shaped

differently from the spot of the second scan lines, and wherein the difference in spot shape produces the region of apparent greater brightness.

The two-dimensional scanning assembly may produce a plurality of generally spaced apart, parallel scan lines that produce a raster-scanned pattern of scan lines on the indicia, wherein the raster scanning assembly comprises a multi-surface reflector having surfaces on the reflector that are differently shaped and positioned relative to one another so that scan lines overlap other scan lines, to produce a region of overlapping scan lines on the indicia, and so that the scanning spot is shaped differently for at least some of the scan lines in the region of overlapping scan lines, and wherein the overlapping scan lines and the difference in spot shape produce the region of apparent greater brightness.

The difference in spot shape may be an enlargement of the area of the spot at the indicia.

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The optical code may comprise rows of optically coded elements, and wherein the region of apparent greater brightness may be an elongated region that is aligned parallel with the rows of optically coded elements in the optical code.

There may be less bright regions above and below the region of apparent greater brightness.

The first and second surfaces may be inclined relative to one another.

The first and second surfaces may be planar.

At least one of the first and second surfaces may be curved.

The difference in spot shape may be produced by at least one curved projection on the surface of the reflector.

There may be a curved projection at approximately the center of the reflector, and the curved projection may have the effect of producing a centrally located region of apparent greater brightness.

There may be at least two curved projections, one at approximately each end of the reflector surface.

The surfaces on the reflector may include first and second surfaces inclined relative to one another along a boundary, and a third surface may comprise a curved projection located at the boundary.

The reflector may rotate about a first axis to produce movement of the scanning spot along a first direction, and wherein the scanning assembly may include a second reflector that rotates about a second axis to produce movement of the scanning spot in a second direction.

The first and second directions of movement of the scanning spot may be generally orthogonal.

Other features and advantages of the invention will be apparent from the following drawings and detailed description of the invention, and from the claims.

The details of one or more embodiments of the invention are set forth in the accompanying drawings and the description below. Other features, objects, and advantages of the invention will be apparent from the description and drawings, and from the claims.

DESCRIPTION OF DRAWINGS

FIG. 1 is an optical schematic of a preferred embodiment of the invention.

FIGS. 2A-2D are diagrammatic views of the manner in which a laser beam is reflected from a mirror toward a target in the embodiment of FIG. 1.

FIG. 3 is a perspective view of the mirror shown in FIG. 2D.

FIG. 4 is a perspective view of the preferred embodiment of the invention in use scanning a two-dimensional bar code.

DETAILED DESCRIPTION

A specific embodiment for use with a two-dimensional bar code symbol such as a PDF417 symbol is shown in FIGS.1-4.

A handheld bar code reader 10 directs a two-dimensionally scanned light beam 12 toward a two-dimensional optical code 14 (e.g., a PDF417 bar code symbol) in a book 16 containing multiple such codes. A region of apparent greater brightness 18 is created as part of the two-dimensional scanning pattern. The region 18 is useful for aligning the scanning pattern with the two-dimensional pattern of the optical code.

Two oscillating mirrors are used to produce a raster scan across a target. Oscillation of the first mirror 20 causes a laser beam 18 (generated by laser source 16) to move up and down across the surface of the second mirror 22. Oscillation of the second mirror causes the beam to move left and right. Together the two oscillating mirrors produce a raster scanned pattern 25 on

target 26, typically at a rate of 30-100 lines per second. A variation in the shape of the reflector of the second mirror 22 is what produces the region of increased apparent brightness.

If the two mirrors both had flat surfaces, the raster scanned pattern would be uniform. But mirror 22 is shaped to produce what would appear to the eye to be a brighter central region 28 in the raster pattern. Two different types of mirror shaping are used to produce the brighter central region. First, the upper half of mirror 22 is slightly inclined from the vertical by 1-2 degrees (exaggerated in the drawing). Although this preferred embodiment of the invention uses a flat surface 22, it is within the scope of the invention to use a curved surface. FIG 2A shows the effect of this inclination. The right to left arrows on the figure diagrammatically represent the laser beam at different vertical positions along the mirror (as caused by oscillations of mirror 20). The first four beams 30 (of course, there will be many more in the raster pattern, but a smaller number are shown in the figure for clarity) emanate from the lower half of the mirror surface and are directed horizontally across to the target 26. The second four beams 32 emanate from the inclined surface of the mirror, and thus are directed at a slightly downward inclination from the horizontal. The result is that the beams emanating from just above the start of the inclination overlap the beams emanating from just below, thereby overlapping some of the beams to produce more beams in the center, and consequently the desired brighter central region 28 of the raster pattern, as it would appear to the eye.

The second type of mirror shaping used on mirror 22 is an elliptical or cylindrical spine along the center line of the mirror. The effect of the spine is shown in FIG. 2B. Reflected beams emanating from the spine are widened in the vertical or "y" direction as a result of the curvature of the spine in the "y" direction. This has the effect of increasing the area of the scanning spot--more specifically, of changing a circular spot to an elliptical spot--on the target in the central region 28, and thus a brightening, to the eye, of the region traversed by the elliptical spot. As discussed in parent application, Serial No. 08/912,147, this also has the effect of changing the working range of the scanner.

Both types of mirror shaping are preferably used together, as shown in FIG. 2D and FIG. 3. Widened and overlapping beams land in the central region 28 of the raster pattern.

An alternative mirror shaping is shown in FIG. 2C. Elliptical or cylindrical shapes along inclined surfaces are provided at the top and bottom of the mirror. The inclination of these shapes has the result of directing reflected beams 36 toward the central region. The elliptical or

cylindrical curvature of these shapes has the effect of widening beams 36. The net result is the desired brighter central region 28.

FIG. 3 shows the three-dimensional appearance of the mirror of FIG. 1 and FIG. 2D. The inclination of the upper half of the mirror is exaggerated, as is the curvature and height of the elliptical or cylindrical spine 24. For reference purposes an XYZ coordinate system has been placed on mirror 22 in FIG. 3. A corresponding XYZ coordinate system has been shown in FIG. 1 on the target. In FIGS. 2A-2D, there is no coordinate system shown, but the vertical direction in the figures is the Y direction, and the reflected beams are generally in the Z direction.

Other embodiments are within the scope of the following claims. For example, with two-dimensional optical codes in which the elements of varying reflectivity are arranged in patterns other than rows, the region of increased apparent brightness need not be linear as shown in FIG. 1, but could take on a different form suited for aligning the scanning pattern with the pattern of elements of the particular two-dimensional code.